How does monetary policy affect the production of new loans? Some evidences from french bank panel data.

Sanvi Avouyi-Dovi[*], Claire Loupias[†] and Patrick Sevestre[‡§]

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[*]Research Center, Banque de France
[†]Research Center, Banque de France
[‡]ERUDITE, Université Paris XII - Val de Marne and Research Center, Banque de France
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1 Introduction

"Though many macroeconomists would profess little uncertainty about it, the profession as a whole has no clear answer to the question of the size and nature of the effects of monetary policy on aggregate activity" Sims (1992). Part of the issue is then to determine the nature of the effects of monetary policy and whether the credit channel has to play a role or not in it. In other words, the question to be answered is to know whether it is possible or not to evaluate the size of the effects of monetary policy without knowing anything about the credit channel. The evidences provided by the literature are based either on macro or microeconomic data, but the underlying models are mostly ad hoc or macroeconomic models.

Using macroeconomic data, Bernanke and Blinder (1992) present evidence consistent with the view that monetary policy works at least in part through "credit" (i.e., bank loans) as well as through "money" (i.e., bank deposits). These empirical evidences are based on a model of monetary policy transmission sketched in Bernanke and Blinder (1988). This model is an analogue to the simple IS-LM model based on the assumption that loans are no longer viewed as perfect substitutes for bonds. It thus allows a symmetric treatment of money and credit which leaves room for a credit channel mechanism to occur. In this model, the credit channel is not seen as "a distinct, free-standing alternative to the traditional monetary transmission mechanism, but rather a set of factors that amplify and propagate conventional interest rate effects". "The credit channel is *thus* an enhancement mechanism, not a truly independent or parallel channel (Bernanke and Gertler (1995))." In their 1992 paper, Bernanke and Blinder, using a VAR model on the United-States, show that "loans seem to respond *slowly* to monetary policy innovations-which makes economic sense because loans are contractual commitments".[1] The composition of the bank assets fall is noteworthy. "For the first six months or so after the policy shock, the fall in assets is concentrated almost entirely in securities; loans hardly move. However, shortly thereafter, security holdings begin gradually to rebuilt, while loans start to fall. By the time two years have elapsed, security holdings have almost returned to their original value, and essentially the entire decline in deposits is reflected in loans. This pattern is just what we should expect. Loans are quasi-contractual commitments whose stock is difficult to change quickly. Banks therefore react to reduced deposits in the short run by selling off securities. In the long run, however, portfolios are rebalanced, with the primary effect falling on loans."

A growing literature using microeconomic data on banks (e.g. Kashyap and Stein (1995, 2000) and Kishan and Opiela (2000) for the United States, M.

[1] They show that the responses to a one-standard deviation (31-basis-point) shock to the funds rate over an horizon of 24 months is a 1.4% decrease of the amount of outstanding loans. Deposits decrease faster (within 9 months instead of two years), but by only 0.8%. The effect on deposits appears to be permanent. The impact on security holdings is transitory. It reaches its peaks in about nine months (a decrease of 1.4%).

Ehrmann et alii (2001) for four European countries and Loupias et alii (2001) for France) also find that a monetary policy tightening generally reduces bank lending. This impact appears to be quite small in European countries, ranging from a decrease of outstanding amounts from half a percent to two percents in the long run for a permanent increase of the monetary policy rate of one percent. Despite it is not possible to compute exactly the same figures from the Kashyap and Stein papers, the impact seems to be no more than twice bigger for the United States than for Europe. All these papers emphasize the role of the credit channel: they show that there are important cross-sectional differences in the way that banks with varying characteristics (size, liquidity, capitalization) respond to policy shocks[2]. They all involve the outstanding amounts of loans or its growth rate as a measure of the impact of monetary policy. Moreover, these regressions are computed, except for Kishan and Opiela (2000), on a reduced form equation often justified by a macroeconomic background.[3]

It is quite surprising that although the intuitive microeconomic justification of the so-called credit view[4], most of the estimated models are based on theoretical macroeconomic models. Baltensperger (1980) surveys alternative approaches to the theory of the banking firm and emphasizes the fact that "a satisfactory theory of bank behavior appears as an indispensable prerequisite for a clear understanding of the workings of the financial sector of the economy in general, and of the money supply mechanism in particular."

The aim of this paper is a tentative to measure the impact of monetary policy on loans granted within a micro founded theoretical framework were the bank maximizes its profits subject to a balance-sheet constraint. This microfoundation involving both loans and deposits is supposed to allow to measure the global effect of both the direct impact of monetary policy (the impact of the textbook interest rate channel) and the "enhancement mechanism" as defined by Bernanke and Gertler (1995) (the impact of the so-called credit channel).

With respect to the previous papers, we take account of the fact that, while we are interested in the impact of monetary policy on *new loans* granted by banks, what we generally observe is the outstanding amount of loans as it appears in their balance sheet. Indeed, because in response to a monetary policy shock, banks can hardly renegotiate the loans they granted in the past, they can only adjust the amount of their new loans, not the total amount of their

[2]All these characteristics seems to be relevant for the US, whereas only liquidity seems relevant for Europe.

[3]Kashyap and Stein (1995) describe a model involving bank asset and liability management, but the estimated equation is ad hoc.

[4]For a reminder of this theory, see for example Bernanke and Gertler (1995). We focus our interest on the "bank lending channel". This channel involves the possible effect of monetary policy actions on the supply of loans by depository institutions. It may only work when deposits and bonds are imperfect substitutes in the balance sheets of banks. In that case, following a reduction in liquidity, banks cannot turn freely to the bond market, due to the external finance premium. Then, they must reduce the amount of loans they supply and/or further increase the interest rate they charge for loans, thus amplifying the initial effects of the monetary policy tightening.

loans engagement (e.g. see C. Lown and S. Peristiani (1996)). We tackle this problem by making explicit the dynamic relationship that exists between the outstanding amount of loans granted by banks and their new loans. The aim of this paper is thus to explain the variations in loans granted to households and non financial companies from monetary financial institutions (MFIs) for the period 1993-2000, using the above mentioned distinction between new loans and outstanding amounts. This paper, contrary to the above mentioned literature, is not involved in studying the existence or the size of the credit channel as a distinct channel. Its aim is rather to evaluate the impact of monetary policy as a whole, including the enhancement mechanism due to the credit channel.

The structure of the paper is as follows: some features about duration of loans are given in section 2. The theoretical model is presented in section 3. Section 4 is devoted to the presentation of the banks dataset we use. Our econometric results are presented and discussed in section 5. Section 6 concludes.

2 New loans versus outstanding stocks.

As already mentioned, the question of the impact of monetary policy on bank lending can be formulated as follows: To which extent do banks modify their supply of *new loans* after a monetary policy change? In other words, how do these monetary policy changes affect the financing of the economy?

However, the problem one faces when looking for a quantitative evaluation of this impact is that the available data do not refer to new loans but to the outstanding amount of loans. Indeed, what we observe in banks balance sheets is, broadly speaking, the cumulative sum of all loans granted by banks in the past minus what has already been paid back by banks debtors. The question then arises of the way one should proceed to get a correct measure of the monetary policy impact on new loans when these are not directly observed. As stated by Lown and Peristiani (1996): "Still, a major criticism of the reduced form loan equations that we (and others) have estimated is that the dependent variable - the stock of outstanding loans - does not measure new loans issued." Indeed, as long as the duration of loans is longer than the periodicity of the data used in the econometric analysis, substituting the outstanding stocks for new loans induces a downward bias in the estimation of the impact of monetary policy. The shorter the period, the larger the bias is likely to be. Moreover, as shown by Baumel (1997), the dynamics of new loans is quite different from that of their outstanding amount, which is another potential source of bias, at least when estimating dynamic models.

Using quarterly bank balance sheet data is then quite likely to generate such biases since the duration of loans is much longer than a quarter. Indeed, the following table presents some figures, elaborated from a survey conducted by the Bank of France about the cost of credit (the so-called "Enquête sur le coût du crédit").

Table 1: Average duration of credits[5] for banks[6]

date	credit to households	credit to non financial business	total
1993	9 years 6 months	1 year 4 months	2 years 3 months
1994	10 years 2 months	1 year 2 months	2 years 6 months
1995	10 years	1 year 2 months	2 years 4 months
1996	10 years	2 years	4 years 9 months
1997	10 years 5 months	1 year 9 months	2 years 11 months
1998	10 years 7 months	2 years	2 years 10 months
1999	11 years 8 months	3 years	4 years 8 months
2000	11 years 10 months	2 years 7 months	4 years 6 months

Even though these figures probably exaggerate the variations of loan duration over time[7], they show that, on average, loans granted to the non financial private sector last from two to more than four years. However, loans to households, which are mainly housing loans, last for about 10 years while those to non financial businesses are granted for a much shorter period, roughly between 12 and 24 months. Assuming a constant rate of reimbursement, this means that the ratio of stock to the new loans as it appears in bank quarterly balance sheet is about 40 for loans to households and between 4 and 8 for loans to businesses. The outstanding amounts can hardly be considered as a satisfactory measure of new loans.

It is important to keep in mind this feature of the economic system to interpret econometric results: outstanding loans are a very bad approximation of new loans. We now turn to the study of our model.

3 The model

3.1 The theoretical model

Microeconomic models aimed at representing bank lending behavior generally stem from the maximization of their profit where the latter is defined using balance sheet items:

$$\Pi_{it} = \sum_{l} R_{it}^{l,t} \ EA_{it}^{l} \ - \sum_{j} S_{it}^{j,t} \ ED_{it}^{j} \ - \ CO_{it} \tag{1}$$

Then EA_{it}^{l} represents the outstanding amount of type l asset of bank i at time t, ED_{it}^{j} that of liabilities of type j, $R_{it}^{l,t}$ and $S_{it}^{j,t}$ the corresponding creditor

[5]To compute the total column, credit to households and to non financial business have been wheighted with the respective loan amounts and survey duration of the two parts of the survey (households and non financial businesses).

[6]This figures don't include loans granted by "Etablissements spécialisés", "Sociétés financières" and "Banques spécialisées" as defined by the terminology of the survey.

[7]This is probably the consequence of sampling variations over time.

and debtor interest rates on the outstanding amount at time t and CO_{it} the operating costs.

For this definition of the profit to be correct, $R_{it}^{l,t}$ and $S_{it}^{j,t}$ have to be defined as "apparent" interest rates, i.e. respectively as the average rate of return on assets l and the cost of having a given amount of debt of type j. However, these variables do not merge with those used by banks as their decision variables. Depending on the type of asset or liability considered, the decision variable is either the instantaneous interest rate (e.g. for loans or for interest-bearing deposits) or the amount of assets/liabilities bought or sold (e.g. for bonds and shares). On the one hand, the apparent rates R_{it}^{t} depend both on the instantaneous rate (r_{it}) and on a mix of past ones (which we denote R_{it}^{t-1}), given that at least a part of the assets/liabilities are the result of bank past decisions. On the other hand, the outstanding amount of assets/liabilities also depends on the bank past decisions, although banks cannot necessarily sell or buy almost freely whatever they wish to. Then, one should take this into account when modelling bank behavior. Indeed, the dynamic relationship linking the amount of newly acquired and sold assets of type l to their outstanding amount can be written as:

$$EA_{it}^{l} \quad = \quad NA_{it}^{l} \; - \; NV_{it}^{l} \quad + \quad EA_{it-1}^{l}\,(1-\delta_{it}^{l}) \tag{2}$$

with :

EA_{it}^{l}: outstanding amount of assets l during period t,

NA_{it}^{l}: newly acquired assets l during period t,

NV_{it}^{l}: assets l sold during period t,

thus ($NA_{it}^{l} - NV_{it}^{l}$): net acquisitions of asset l at time t

δ_{it}^{l} = "depreciation" rate of asset l for bank i during period t. For the sake of simplicity it is assumed to be constant over time and across banks ($\delta_{it}^{l} = \delta^{l}$), which is a quite strong assumption.

The same relationship as above applies to liabilities, except that we assume that banks cannot re-buy their own debts :

$$ED_{it}^{j} \quad = \quad ND_{it}^{j} \quad + \quad ED_{it-1}^{j}\,(1-\gamma^{j}) \tag{3}$$

In that case again, and in particular for deposits, γ^{j} is unknown, given that bank customers can decide to withdraw their deposits at any time.

Then, banks profit can be re-written as:

$$\begin{aligned}\Pi_{it} \quad = \quad & \sum_{l} r_{it}^{l}\, NA_{it}^{l} \; + \sum_{l} R_{it}^{l,t-1}\,[(1-\delta^{l})\, EA_{it-1}^{l} - NV_{it}^{l}\,] \\ & - \sum_{j} s_{it}^{j}\, ND_{it}^{j} \; - \sum_{j} S_{it}^{j,t-1}\,(1-\gamma^{j})\, ED_{it-1}^{j} - \; CO_{it}\end{aligned} \tag{4}$$

with r_{it}^{l} and s_{it}^{j} the instantaneous interest rates, i.e. respectively the rate of return on new assets l and the cost of having a new given amount of debt of type j. $R_{it}^{l,t-1}$ and $S_{it}^{j,t-1}$ are respectively the creditor and debtor interest rates during period t which apply to assets and debts owned during period t, *but* acquired before period t, i.e. already owned at date $t-1$.

The balance sheet constraint can then be written as:

$$\sum_l NA_{it}^l - \sum_l NV_{it}^l + \sum_l (1-\delta^l)\, EA_{it-1}^l = \sum_j ND_{it}^j + \sum_j (1-\gamma^j)\, ED_{it-1}^j \quad (5)$$

Banks current profit clearly appears to depend not only on their current decisions but also on past ones. Indeed, commitments induced by past decisions must be fulfilled. Then, this re-writing of banks profit allows us to make more explicit banks decision variables.

More precisely, the (outstanding amounts or newly acquired) assets are:
A_{it}^1: cash and interbank transaction assets (with $\delta^1 = 1$, thus $NV_{it}^1 = 0$),
A_{it}^2: customer loans for bank i during period t (with $NV_{it}^2 = 0$),
A_{it}^3: security holdings,
D_{it}^1: interbank transaction liabilities (with $\gamma^1 = 1$),
D_{it}^2: deposits,
D_{it}^3: bonds and money market liabilities.

for sake of simplicity A_{it}^4, permanent immobilizations, and D_{it}^4, capital and reserves, are ignored.

For loans, the depreciation rate δ^2 depends on repayments as contractually scheduled. However, there may exists payment defaults and anticipated repayments which make δ^2 not perfectly anticipated by banks. Since this is not under the bank control, we can consider this depreciation rate as exogenous. We assume that banks loans are not re-negotiable on a secondary market, so that past loans cannot be sold ($NV_{it}^2 = 0$). Then, one can write down the dynamic relationship between the (unobserved) new loans NA_{it}^2 and their stock EA_{it}^2, as they appear in bank balance sheets, as:

$$NA_{it}^2 = EA_{it}^2 - (1-\delta^2)\; EA_{it-1}^2 \quad (6)$$

One can easily assume that δ^1 and γ^1 equal one as cash and interbank transaction are very short term operations.

Using this particularities, one can re-right the profit as:

$$\begin{aligned}\Pi_{it} = {} & R_{it}^{1,t}\; EA_{it}^1 + r_{it}^2\, NA_{it}^2 + R_{it}^{2,t-1}(1-\delta^2)\, EA_{it-1}^2 + R_{it}^{3,t}\; EA_{it}^3 \\ & - \sum_j s_{it}^j\, ND_{it}^j - \sum_j S_{it}^{j,t-1}\,(1-\gamma^j)\, ED_{it-1}^j - CO_{it} \quad (7)\end{aligned}$$

Assuming the credit market to be non perfectly competitive, banks determine the interest rate on their new loans r_{it}^2 so as to maximize their profit. They also decide the amount of securities they want to hold EA^3_{it} in their portfolio. It is assumed that the arbitrage condition is fulfilled[8] on the security market, that is $R^{3,t-1}_{it} = R^{3,t}_{it} = r^3_{it}$.[9]

Maximization of (7), with respect to r^2_{it} and EA^3_{it}, under constraint (5) leads to[10] the following first order condition[11]:

$$\begin{aligned}\frac{\partial EA^1_{it}}{\partial r^2_{it}}(R^{1,t}_{it} - R^{3,t}_{it}) \quad + \quad & NA^2_{it} + \frac{\partial NA^2_{it}}{\partial r^2_{it}}(r^2_{it} - R^{3,t}_{it}) \\ & - \sum_j \frac{\partial ND^j_{it}}{\partial r^2_{it}}(s^j_{it} - R^{3,t}_{it}) = 0 \qquad (8)\end{aligned}$$

assuming that $\frac{\partial CO_{it}}{\partial r^2_{it}} = 0$, $\frac{\partial R^{1,t}_{it}}{\partial r^2_{it}} = 0$, $\frac{\partial R^{2,t-1}_{it}(1-\delta^2)EA^2_{it-1}}{\partial r^2_{it}} = 0$, $\frac{\partial R^{3,t}_{it}}{\partial r^2_{it}} = 0$, $\frac{\partial s^j_{it}}{\partial r^2_{it}} = 0$, $\frac{\partial R^{3,t}_{it}}{\partial EA^3_{it}} = 0$ and that $\frac{\partial CO_{it}}{\partial EA^3_{it}} = 0$.

$\frac{\partial R^{2,t-1}_{it}}{\partial r^2_{it}} = 0$ means that the interest payments on loans decided before date t, are not modified by variation of the interest rate at date t. $\frac{\partial \delta^2 EA^2_{it-1}}{\partial r^2_{it}} = 0$ means that repayments on loans are not modified (e.g. loans are not repaid earlier) if the interest on loans is increasing or decreasing.

3.2 The econometric model

Unfortunately, newly acquired loans are generally not observable. However, one can use the dynamic relationship linking new loans and the outstanding amount of loans

$$NA^2_{it} = EA^2_{it} - EA^2_{it-1}(1-\delta^2) \qquad (9)$$

Thus one can write:

$$\begin{aligned}&\frac{\partial EA^1_{it}}{\partial r^2_{it}}(R^{1,t}_{it} - R^{3,t}_{it}) + EA^2_{it} - EA^2_{it-1}(1-\delta^2) + \frac{\partial NA^2_{it}}{\partial r^2_{it}}(r^2_{it} - R^{3,t}_{it}) \\ &- \sum_j \frac{\partial ND^j_{it}}{\partial r^1_{it}}(s^j - R^{3,t}_{it}) = 0 \qquad (10)\end{aligned}$$

[8]This is not perfectly true accountingly speaking, as only "transaction" securities are registered to their market price. The "investment" securities are registered at their purchase price. Thus in this latter case the apparent interest rate does not include gains and losses.

[9]Deciding EA^3_{it} is thus equivalent to decide $NA^3_{it} - NV^3_{it}$ the net acquisition of securities.

[10]See appendix 1 for more details.

[11]This is close to the specification considered by A. Worms (2001). See also E. Elyasiani et *alii* (1995).

This allows to have a consistently defined equation in the sense that the model makes explicit the impact of any change in the loans interest rate, considered as a decision variable.

Unfortunately, this equation still contains unobservable variables since, at the micro level, the interest rates on new assets r^l_{it} (respectively on new liabilities s^j_{it}) are not observable.

A way to tackle this lack of data is to compute a rate of return of loans as the ratio of revenues associated with these loans to their outstanding stock ($R^{2,t}_{it}$), as they appear in bank accounts and balance sheets. This solution presents three advantages. The first one is that it is quite simple to implement. The second one is that it allows to get bank specific interest rates. Indeed, although the nature of competition should lead to an homogeneity of the interest rates across banks, the data show this is not exactly the case, at least when one considers the total amount of loans. One possible explanation rests in the differences that exist across banks about the structure of the loans they grant. Indeed, interest rates differ depending on the type of loan. Then, "average" loans interest rates for banks specialized in short term business loans are likely to be different from those of banks specialized in say, housing loans. The third advantage is that this information can be collected for a large number of banks, once their balance sheet and accounts are available. Obviously, the drawback of this solution is that, during periods where interest rates strongly change over time, the discrepancy between the interest rate on newly granted loans (r^2_{it}) and this "apparent" interest rate ($R^{2,t}_{it}$) can be quite significant.

Generalizing the previous statement, r^l_{it} (respectively s^j_{it}) will be approximated by $R^{l,t}_{it}$ (respectively $S^{j,t}_{it}$) in econometric computations. This was already the case for $R^{3,t}_{it}$, as one previously assumed that the arbitrage condition is fulfilled on the security market.

Now, in order to make our model fully estimable, we have to make further assumptions about $\partial EA^1/\partial r^2$, $\partial NA^2/\partial r^2$ and $\partial ND/\partial r^2$. We assume that:

$$\begin{aligned}
\partial EA^1_{it}/\partial r^2_{it} &= \varepsilon^{EA^1_{it}}_{r^2_{it}}\ EA^1_{it};\\
\partial NA^2_{it}/\partial r^2_{it} &= \varepsilon^{NA^2_{it}}_{r^2_{it}} NA^2_{it};\\
\partial ED^1_{it}/\partial r^2_{it} &= \varepsilon^{ED^1_{it}}_{r^2_{it}}\ ED^1_{it};\\
\partial ND^j_{it}/\partial r^2_{it} &= \varepsilon^{ND^j_{it}}_{r^2_{it}}\ ND^j_{it} \text{ for } j = 2,3;
\end{aligned}$$

where ε is the semi-elasticity of assets or liabilities with respect to r^2_{it} (e.g. $\varepsilon^{NA^2_{it}}_{r^2_{it}} = (\partial NA^2_{it}/NA^2_{it})/\partial r^2_{it}$). These semi-elastcicies might be seen as demand elasticities for assets or liabilities with respect to the loan interest rate. The bank is thus not seen as a price taker, but as a monopolist optimizing along the loan demand curve of the public. The same apply to interbank or demand deposits and security liabilities. For sake of simplicity, these semi-elasticities are assumed to be constant. This is a quite strong assumption as the bank clientele structure might vary with the characteristics of the bank.

From equation (10) one can derive the following regression equation using the previous set of assumptions[12]:

$$\begin{aligned}
EA_{it}^2 \quad = \quad & -\,\varepsilon_{r^2}^{EA\,1} EA_{it}^1\ (R_{it}^{1,t} - R_{it}^{3,t}) \\
& +(1-\delta^2)\ \ EA_{i,t-1}^2 \\
& -\,\varepsilon_{r^2}^{NA\,2}\ EA_{it}^2(R_{it}^{2,t} - R_{it}^{3,t})\ +\ \varepsilon_{r^2}^{NA^2}(1-\delta^2)EA_{i,t-1}^2\ (R_{it}^{2,t} - R_{it}^{3,t}) \\
& +\varepsilon_{r^2}^{ED\,1}\ ED_{it}^1(S_{it}^{1,t} - R_{it}^{3,t}) \\
& +\,\varepsilon_{r^2}^{ND\,2} ED_{it}^2(S_{it}^{2,t} - R_{it}^{3,t})\ -\ \varepsilon_{r^2}^{ND\,2}(1-\gamma^2)ED_{i,t-1}^2(S_{it}^{2,t} - R_{it}^{3,t}) \\
& +\,\varepsilon_{r^2}^{ND\,3} ED_{it}^3(S_{it}^{3,t} - R_{it}^{3,t})\ -\ \varepsilon_{r^2}^{ND\,3}(1-\gamma^3)ED_{i,t-1}^3(S_{it}^{3,t} - R_{it}^{3,t})
\end{aligned} \tag{11}$$

The expected signs of the regression are the following ones:

$(1-\delta^2)$ is supposed to be positive and smaller than one. $(-\ \varepsilon_{r^2}^{NA\,2})$ should be positive, as new loans granted are decreasing with the level of the interest rate. $\varepsilon_{r^2}^{NA\,2}(1-\delta^2)$ should be consistent with the two previous coefficients.

$\varepsilon_{r^2}^{ED\,1}$, $\varepsilon_{r^2}^{ND\,2}$ and $\varepsilon_{r^2}^{ND\,3}$ signs should be negative as liabilities increase with loans and loans are decreasing with the interest rate. Obviously, $(-\ \varepsilon_{r^2}^{ND\,1}(1-\gamma^1))$ and $(-\ \varepsilon_{r^2}^{ND\,3}(1-\gamma^3))$ should then be positive and consistent with the fact that $(1-\gamma^1)$ and $(1-\gamma^3)$ should be smaller than one.

The signs of $(-\ \varepsilon_{r^2}^{EA^1})$ is not obvious at all. Indeed, even the sign of the substitution effect between EA^1 and NA^2 (for a given size of balance sheet) is unknown, because EA^3 may also be used as a substitute. On top of that, increases in r^2 may induce decreases in the balance sheet size, which may induce decreases in EA^2 all things being equal.

4 From the bank dataset to the econometric sample

The Commission Bancaire collects quarterly balance sheet data and bi-annual income statement data for all MFIs having an activity in France. These individual data are available for the period 1993-2000 and for about 1000 MFIs with a bi-annual periodicity. Nevertheless, we use only loans to consumers and non financial business firms, so we need the bank clientele structure of each

[12]where the regressors are

$$\begin{aligned}
& EA_{it}^1\ (R_{it}^{1,t} - R_{it}^{3,t}), EA_{i,t-1}^2,\ EA_{it}^2(R_{it}^{2,t} - R_{it}^{3,t}),\ EA_{i,t-1}^2\ (R_{it}^{2,t} - R_{it}^{3,t}), \\
& ED_{it}^1(S_{it}^{1,t} - R_{it}^{3,t}), ED_{it}^2(S_{it}^{2,t} - R_{it}^{3,t}), ED_{i,t-1}^2(S_{it}^{2,t} - R_{it}^{3,t}), \\
& ED_{it}^3(S_{it}^{3,t} - R_{it}^{3,t}),\ ED_{i,t-1}^3(S_{it}^{3,t} - R_{it}^{3,t})
\end{aligned}$$

MFI. MFIs clientele structure is only available for 92 % (respectively 81 %) of MFIs, for the first semester of 2000 (respectively for the first semester of 1993). Nevertheless, the corresponding share on total asset is 98 % (respectively 97 %). A more detailed description of this data set is given in Loupias et alii (2001).

The credit cost survey also provide figures on interest rates on bank new loans on a quarterly basis. As we have seen above, this is a very important information to study monetary policy. This figures will be used to study the robustness of the results presented here in a forthcoming version of the paper.

A potentially severe problem comes from the large number of bank mergers that took place during the observation period. Merger entities are reconstructed backward as the sum of the merging banks before the merger (as in Loupias et alii (2001)).

Outliers have been defined in the following way:

1) observations below the 2^{nd} and above the 98^{th} percentile of the growth rate of total assets,

2) observations below the 5^{th} and above the 95^{th} percentile for each "apparent" interest rates, i.e. respectively the rate of return on assets l and the cost of having a given amount of debt of type j.

3) observations below the first and above the last percentile of the first difference of loan, liquidity, and capitalization ratios.

Moreover, banks with no loans have been discarded from the sample and, because of the computation of first differences and their lags, we have kept only banks for which we have at least five consecutive observations.

Only between 15% and 20% of banks, that is around 45% of market share on total assets (55% on loans) are kept in the econometric sample.

5 The econometric results

5.1 Estimating the elasticity of bank lending to the interest rate.

Table 1 OLS, 2SLS and GMM estimates of the First Order Condition equation.

		OLS		2SLS		GMM	
estimated coeff	exp. sign	coeff.	std. dev.	coeff.	std. dev.	coeff.	std. dev.
$-\ \varepsilon_{r^2}^{EA^1}$	unknown	3.063	0.192	3.313	0.960	3.328	0.026
$(1-\delta^2)$	positive (<1)	0.875	0.007	0.858	0.058	0.858	0.000
$-\ \varepsilon_{r^2}^{NA^2}$	positive	3.101	0.681	19.476	3.120	19.585	0.094
$+\ \varepsilon_{r^2}^{NA^2}(1-\delta^2)$	negative	-0.304	0.703	-16.137	4.449	-16.233	0.101
$+\varepsilon_{r^2}^{ED^1}$	negative	-2.552	0.184	-2.933	1.024	-2.954	0.024
$+\ \varepsilon_{r^2}^{ND^2}$	negative	-6.287	0.357	-8.810	1.167	-8.828	0.035
$-\ \varepsilon_{r^2}^{ND^2}(1-\gamma^2)$	positive	4.580	0.393	7.095	1.289	7.124	0.037
$+\ \varepsilon_{r^2}^{ND^3}$	negative	-3.905	0.415	-4.117	1.516	-4.255	0.051
$-\ \varepsilon_{r^2}^{ND^3}(1-\gamma^3)$	positive	1.163	0.417	1.293	1.268	1.423	0.055
Constant		-0.000	0.000	0.000	0.000	0.000	0.000
Sargan stat.	(signif.)					41.984	(0.227)
m1	(signif.)	7.044	(0.000)	1.649	(0.099)	1.941	(0.052)
m2	(signif.)	0.647	(0.517)	-0.569	(0.569)	-0.440	(0.659)
number of obs.		1773		1773		1773	

Notes:

1) Time dummies are included in the regressions but, their coefficients (whose sum is restricted to be null) are not reported here .

2) The list of instruments is as follows: lags 2 of the first differences of the following variables: loans, cash and interbank transaction assets, security holdings, interbank transaction liabilities, bonds and money market liabilities. Moreover, to increase efficiency, this instrument set has been expanded according to Arellano and Bond's procedure, i. e. all instruments have been multiplied by time dummies.

3) The T-statistics reported for the 2SLS estimates are robust ones, accounting for heteroscedasticity and serial correlation.

All the coefficients have the expected sign. The product of the second and the third parameters is approximately equal to the opposite of the fourth one, which means that the implicit constraint is also fulfilled. The results obtained with OLS and GMM are quite different, specially as far as $\varepsilon_{r^2}^{NA^2}$ is concerned. Disturbance serial correlation of order one is normal, since the model estimated has a dynamic of order one. There is no autocorrelation of order 2. The sargan statistics is significant. Thus the model is accepted.

A further interpretation of the coefficients and elasticities is given in section 5.3.

5.2 Estimating the impact of monetary policy on bank lending.

In order to evaluate the impact of monetary policy on the amount of loans granted by banks, we need a second step, linking the monetary policy indicator to the loan interest rate. In order to compute the elasticity of the loan interest rate with respect to the monetary policy rate, we shall make use of our estimated model, together with auxiliary regressions linking the other various interest rates to the monetary policy indicator.

The theoritical link between the loan interest rate and policy rate in our model

The loan interest rate is an endogeneous variable in our model. The implicit link between this rate and the policy rate within our model may be computed using the following procedure. If one derives equation (11) with respect to the policy rate, using if necessary the decomposition with respect to the loan interest rate, one can compute the relation between the derivative of the loan interest rate with respect to the policy rate as a function of the "other" interest rates and the previous estimated coefficient. Knowing the relationship between the "other" interest rate and the policy rate, may allow to compute the derivative of the loan interest rate with respect to the policy rate in a consistent framework.

The estimated link between the "other" interest rate and policy rate in our model

We now need an estimation of the impact of the policy rate on all the rate used by the bank except for the loan interest rate which is endogeneously determined. For the sake of simplicity, we evaluate this impact by a simple regression of the various bank interest rates on the PIBOR3M rate, as well as on bank specific variables, to account for the likely heterogeneity of this impact. The equations we estimate can be written as:

$$\begin{aligned} R^l_{it} &= a_0 + a_1\, pibor3m_t + a_2\, pibor3m_t \times size_i + a_3\, pibor3m_t \times rcap_{it} \\ &\quad + a_4\, pibor3m_t \times rliq_{it} + a_5\, size_i + a_6\, rcap_{it} + a_7\, rliq_{it} + \varepsilon_{it} \end{aligned}$$

with $l = 1, 3$.[13]

$$\begin{aligned} S^j_{it} &= a_0 + a_1\, pibor3m_t + a_2\, pibor3m_t \times size_i + a_3\, pibor3m_t \times rcap_{it} \\ &\quad + a_4\, pibor3m_t \times rliq_{it} + a_5\, size_i + a_6\, rcap_{it} + a_7\, rliq_{it} + \varepsilon_{it} \end{aligned}$$

with $j = 1, 2, 3$.

The bank characteristics are defined in the following way. The size is defined as the log of total assets, liquidity as the ratio of cash and interbank assets over total assets, and capitalization as the ratio of capital and reserves over total assets. More over, all these characteristics are normalized in order to be equal

[13] For memory and comparisons, we also compute the regression for $l = 2$. But this is inconsistent with our model, as far as the loan interest rate is suppose to be the solution of an optimization program. This regression is computed in appendix 2.

to zero for the average of the regression sample. The estimation results are provided in the following tables:

Interbank asset rate (R^1_{it}) estimation.

variable	coeff.	t-stat.	coeff.	t-stat.
constant	0.02992	5.31	0.02982	5.34
pibor3m	0.83779	5.50	0.84070	5.58
pibor3m*size	-0.13681	-1.17	-	-
pibor3m*rliq	0.09127	0.11	-	-
pibor3m*rcap	-0.37531	-0.11	-	-
size	0.01497	3.44	0.00996	15.17
rliq	-0.06727	-2.15	-0.06386	-13.49
rcap	0.11631	0.89	0.10192	5.49
R^2	0.18		0.18	

Security asset yield (R^3_{it}) estimation.

variable	coeff.	t-stat.	coeff.	t-stat.
constant	0.03154	9.40	0.03176	9.54
pibor3m	0.18634	2.05	0.17958	2.00
pibor3m*size	0.13463	1.93	-	-
pibor3m*rliq	0.19502	0.39	-	-
pibor3m*rcap	4.09272	1.93	-	-
size	-0.00133	-0.51	0.00363	9.87
rliq	0.02307	1.24	0.03022	10.80
rcap	-0.15035	-1.94	-	-
R^2	0.14		0.14	

Interbank liability rate (S^1_{it}) estimation.

variable	coeff.	t-stat.	coeff.	t-stat.
constant	0.02280	7.43	0.02279	7.49
pibor3m	0.89499	10.79	0.89537	10.90
pibor3m*size	-0.06100	-0.95	-	-
pibor3m*rliq	0.23403	0.51	-	-
pibor3m*rcap	1.71136	0.88	-	-
size	0.00342	1.44	0.00119	3.31
rliq	-0.01884	-1.10	-0.01023	-3.97
rcap	-0.01291	-0.18	0.04878	4.83
R^2	0.08		0.08	

Deposit rate (S^2_{it}) estimation.

variable	coeff.	t-stat.	coeff.	t-stat.
constant	0.01465	7.28	0.01450	7.26
pibor3m	0.24569	4.52	0.25014	4.64
pibor3m*size	0.01381	0.33	-	-
pibor3m*rliq	0.22786	0.75	-	-
pibor3m*rcap	3.20935	2.53	2.88992	2.45
size	-0.00163	-1.05	-0.00112	-4.79
rliq	0.03391	3.03	0.04224	25.00
rcap	-0.10418	-2.24	-0.09244	-2.14
R^2	0.27		0.27	

Security liability rate (S^3_{it}) estimation.

variable	coeff.	t-stat.	coeff.	t-stat.
constant	0.02395	5.15	0.02422	5.22
pibor3m	0.48144	3.83	0.47400	3.78
pibor3m*size	0.04110	0.42	-	-
pibor3m*rliq	-1.81684	-2.60	-1.76785	-2.60
pibor3m*rcap	0.62982	0.21	-	-
size	0.00069221	0.19	0.00191	3.75
rliq	0.10329	3.99	0.10071	4.01
rcap	0.00105	0.01	-	-
R^2	0.08		0.08	

The estimated link between the loan interest rate and policy rate in our model

At the sample average, all bank characteristics are nil. So, it is very easy to compute the relationship between each interest rate and the policy rate. If one also knows the average values for the outstanding amounts, the "apparent" rates and the value of the estimated coefficients one can compute the impact of monetary policy on the loan interest rate.

At the sample average, the impact of a one point change in the monetary policy indicator on the loan interest rate (ρ) can be evaluated to 0.409 (which is close to the impact after 3 months obtained by Mojon (2001) for France on a macroeconomic basis over the period 1992-98 [14]). As the semi-elasticities, estimated in the previous subsection, are for an increase in the loan interest rates, one has to multiply them by ρ=0.409 to know the direct impact of monetary policy. These results are interpreted below.

[14] This estimation is roughly half of the estimation reported in Baumel and Sevestre (2000). This difference may be explained in two different ways. The first one is that Baumel and Sevestre computations are made assuming the constancy of the balance sheet structure of banks. The explanation of the smaller impact of monetary policy could then come from the modification of the balance sheet structure. An other technical explanation could come from the fact that the computation of this section involves so many estimated coefficients, that the estimation consistent with our framework might be not accurate enough.

5.3 Economic significance of the results

5.3.1 Depreciation rates and duration

The model gives estimations for the parameters δ^2 , γ^2 and γ^3 which are respectively the depreciation rates for half a year of loans, deposits and securities liabilities (without capital). The table below presents this figures[15] with the corresponding duration on an annual basis. The duration is computed, using the assumption of the constancy of the depreciation rates, as the inverse of the depreciation rate.

	depreciation rate	duration
loans	$2 * \delta^2 = 0.28$	3 years 6 months
deposits	$2 * \gamma^2 = 0.39$	2 years 6 months
security liabilities[16]	$2 * \gamma^3 = 1.33$	9 months

One may notice that despite these figures are estimated from a completely different dataset, the average duration obtained for loans is consistent with the figures from the "credit cost survey": 3 years and 1 month for total credits on average over the whole period.

5.3.2 Impact of monetary policy

The model gives estimations for the parameters $\varepsilon_{r^2}^{EA\,1}$, $\varepsilon_{r^2}^{NA\,2}$, $\varepsilon_{r^2}^{ND\,1}$, $\varepsilon_{r^2}^{ED\,2}$ and $\varepsilon_{r^2}^{ND\,3}$. So demand semi-elasticities on new loans and other items to the loan interest rates are known. And as we know the coefficient of repercussion of monetary policy on loan interest rate, it will be possible to compute the impact of monetary policy on new loans and other items as the product of the elasticity and the coefficient of repercussion (ρ).[17]

The semi-elasticity of outstanding stocks to loan interest rate may be computed in the following way. One knows that :

$$EA_{it}^2 = NA_{it}^2 + EA_{it-1}^2(1 - \delta^2)$$

so, $\partial EA_{it}^2/\partial r_{it}^2 = \ \partial NA_{it}^2/\partial r_{it}^2 + 0$, and $\frac{\partial EA_{it}^2/EA_{it}^2}{\partial r_{it}^2} = \frac{\varepsilon_{r^2}^{NA\,2} NA_{it}^2}{NA_{it}^2 + EA_{it-1}^2(1-\delta^2)}$

as long as EA_{it}^2 is not too far from EA_{it-1}^2, one may approximately write that $EA_{it}^2 = \frac{NA_{it}^2}{\delta^1}$. Thus, one may write that $\frac{\partial EA_{it}^2/EA_{it}^2}{\partial r_{it}^2} = \delta^2 \varepsilon_{r^2}^{NA\,2}$.

So not only it is possible to compute the impact of monetary policy on new loans, but also on outstanding amounts after one semester. This is also true for deposits and bonds and security liabilities.

[15]These figures come almost directly from the estimated coefficients. For example, δ^2 is equal to (1 - 0.858), with 0.858 the estimated coefficient for $(1 - \delta^2)$ on a semi-annual basis. It has to be multiplied by two in order to know the depreciation rate on an annual basis.

[16]Security liabilities include CDs, MTN, and various other liabilities.

[17]Remember that flows and outstandings are the same for cash and interbank transactions.

IMPACT OF	MONETARY	POLICY	(assets)
	cash and interbank	loans	security holdings
on new...	$\rho\varepsilon_{r^2}^{EA^1}$ =-1.4	$\rho\varepsilon_{r^2}^{NA^2}$ =-8.0	n.a.
on outstanding ...	$\rho\varepsilon_{r^2}^{EA^1}$ =-1.4	$\rho\varepsilon_{r^2}^{NA^2}\delta^2$ =-1.1	n.a.

IMPACT OF	MONETARY	POLICY	(liabilities)
	cash and interbank	deposits	security liabilities
on new...	$\rho\varepsilon_{r^2}^{ED^1}$ =-1.2	$\rho\varepsilon_{r^2}^{ND^2}$ =-3.6	$\rho\varepsilon_{r^2}^{ND^3}$ =-1.7
on outstanding...	$\rho\varepsilon_{r^2}^{ED^1}$ =-1.2	$\rho\varepsilon_{r^2}^{ND^2}\gamma^2$ =-0.7	$\rho\varepsilon_{r^2}^{ND^3}\gamma^3$ =-1.1

So the increase of one percentage point of the monetary policy rate will induce a decrease of new loans of 8.0 % and a decrease in the outstanding amount of loans of 1.1% after half a year. The impact on deposits is lower than the impact on loans. This is consistent with the fact that monetary policy works partly through the bank lending channel.

If we study the dynamics for loans starting from a steady state, using both the fact that the dynamic relation is

$$EA_{it}^2 = NA_{it}^2 + (1 - \delta^2)EA_{it-1}^2 \qquad (12)$$

and the fact that new loans have decreased of 8.0 %, the cumulative impact of a permanent increase of 1 % point of the interest rate on outstanding amounts of loans may be computed[18]. The same story applies for deposits and security liabilities. They are described by the following table.

cumulative impact after a 1 % point increase of monetary policy rate (%)	loans	deposits	security liabilities
a semester	-1.1	-0.7	-1.2
a year	-2.1	-1.3	-1.6
two years	-3.6	-2.1	-1.7
five years	-6.2	-3.2	-1.7
ten years	-7.6	-3.5	-1.7
∞	-8.0	-3.6	-1.7

Of course, this dynamic is computed every thing else being equal (GDP is constant for instance). It only describes what the impact of monetary policy would be on an average bank in a word without any growth.

Nevertheless, it seems that the magnitude of the impact on loans of monetary policy is not the same at all, when one tries to take some account of

[18] We start from a steady state $EA_{it}^2 = EA_{it-1}^2$ normalized to 100. Knowing the dynamic relation $EA_{it}^2 = NA_{it}^2 + (1 - \delta^2)EA_{it-1}^2$ and the value of $\delta^2 = 0.14$, this implies $NA_{it}^2 = 14$. As we know that NA_{it}^2 decreases by 8.0% after a monetary policy increase of one point, one can easily compute the dynamic of EA_{it}^2.

the flow/outstanding distinction. The long run monetary impact of an increase of the policy rate of 1 % obtained in Loupias et alii (2001) was of 1.9 % decrease of the outstanding amount of loans. This figure has to be compared with 8.0 % here. The figures obtained by Kashyap and Stein (1995) on outstanding amounts for the United-States were also quite small. Unfortunatly it's not possible to compute the long run coefficients from the results exposed in their paper.

This results should also be compared with macroeconomics estimations. Comparisons with the results from the VAR model need to compute the previous table for a shock of only 1/3 % point on the monetary policy rate.

cumulative impact after a 1/3 % point increase of monetary policy rate (%)	loans	deposits	security liabilities
a semester	-0.4	-0.2	-0.4
a year	-0.7	-0.4	-0.5
two years	-1.2	-0.7	-0.6
five years	-2.1	-1.1	-0.6
ten years	-2.5	-1.2	-0.6
∞	-2.7	-1.2	-0.6

These results are quite similar to the one obtained by Bernanke and Blinder (1992) for the United States for loans and deposits over an horizon of two years. Nevertheless the total impact is supposed to be achived after two years in their paper.

6 Conclusion

In this paper we explicitly tackle with the fact that the impact of monetary policy on loans applies only on new loans and not on the outstanding amounts. Taking explicitly the dynamic of loans into account leads to considerably bigger estimates of the impact of monetary policy on loans (almost five times bigger) than the existing estimations computed with micro bank data.

In the previous study, we have assumed that all banks react in the same way to changes in interest rates. This is a rather strong assumption which can be easily softened by splitting the sample according to banks' size and/or other characteristics. Our intention for further research is first to pay a particular attention to the banks clientele structure. Indeed, it is likely that the reaction of bank lending to changes in monetary policy differ across different types of loans: either because of banks ability to shrink more easily their supply for certain types of loans or because their customers can, for some of them, substitute other sources of finance to bank loans when these last are reduced. A second set of solution to take heterogeneity into account would be to estimate the model on the whole bank population while taking account at the same time of the bank characteristics as size, liquidity or capitalization.

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8 Appendix 1

Banks' maximization problem may be written as reported below (from equation (7) and (5) of the body text):

Maximization of

$$\begin{aligned}\Pi_{it} &= R_{it}^{1,t}\ EA_{it}^{1}\ + r_{it}^{2}\,NA_{it}^{2}\ + R_{it}^{2,t-1}(1-\delta^2)\,EA_{it-1}^{2} + R_{it}^{3,t}\ EA_{it}^{3} \\ &\quad -\sum_j s_{it}^{j}\,ND_{it}^{j}\ -\sum_j S_{it}^{j,t-1}\,(1-\gamma^j)\,ED_{it-1}^{j} -\ CO_{it} \end{aligned} \tag{13}$$

with respect to r_{it}^2 and EA_{it}^3,

under the constraint

$$EA_{it}^{1}\ + NA_{it}^{2}\ + (1-\delta^2)\,EA_{it-1}^{2} + EA_{it}^{3} = \sum_j ND_{it}^{j} + \sum_j\ (1-\gamma^j)\,ED_{it-1}^{j} \tag{14}$$

Maximisation of (13), with respect to r_{it}^2 and EA_{it}^3, under constraint (14) leads to the following Lagrangean:

$$\begin{aligned} L &= R_{it}^{1,t}\ EA_{it}^{1}\ +\ r_{it}^{2}\,NA_{it}^{2}\ + R_{it}^{2,t-1}(1-\delta^2)\,EA_{it-1}^{2} + R_{it}^{3,t}\ EA_{it}^{3} \\ &\quad -\sum_j s_{it}^{j}\,ND_{it}^{j}\ -\sum_j S_{it}^{j,t-1}\,(1-\gamma^j)\,ED_{it-1}^{j} -\ CO_{it} \\ &\quad -\lambda\left[\begin{array}{c} EA_{it}^{1}\ + NA_{it}^{2}\ + (1-\delta^2)\,EA_{it-1}^{2} + EA_{it}^{3} \\ -\sum_j ND_{it}^{j} - \sum_j\ (1-\gamma^j)\,ED_{it-1}^{j} \end{array}\right] \end{aligned} \tag{15}$$

First order conditions assuming that $\frac{\partial CO_{it}}{\partial r_{it}^2} = 0$, $\frac{\partial R_{it}^1}{\partial r_{it}^2} = 0$, $\frac{\partial R_{it}^{2,t-1}(1-\delta^2)\,EA_{it-1}^2}{\partial r_{it}^2} = 0$, $\frac{\partial R_{it}^3}{\partial r_{it}^2} = 0$, $\frac{\partial s_{it}^j}{\partial r_{it}^2} = 0$, $\frac{\partial R_{it}^3}{\partial EA_{it}^3} = 0$ and that $\frac{\partial CO_{it}}{\partial EA_{it}^3} = 0$, may be written as:

$$\begin{aligned} \frac{\partial L}{\partial r_{it}^2} &= 0 \\ &\Leftrightarrow\ R_{it}^{1,t}\frac{\partial EA_{it}^1}{\partial r_{it}^2} + NA_{it}^2\ + r_{it}^2\ \frac{\partial NA_{it}^2}{\partial r_{it}^2} + 0 + R_{it}^{3,t}\frac{\partial EA_{it}^3}{\partial r_{it}^2} - \sum_j s_{it}^{j}\frac{\partial ND_{it}^{j}}{\partial r_{it}^2} - 0 \\ &\quad -\lambda\ \left[\frac{\partial EA_{it}^1}{\partial r_{it}^2} + \frac{\partial NA_{it}^2}{\partial r_{it}^2} + 0 + \frac{\partial EA_{it}^3}{\partial r_{it}^2} - \sum_j \frac{\partial ND_{it}^{j}}{\partial r_{it}^2} - 0\right] \\ &= 0 \end{aligned} \tag{16}$$

$$\frac{\partial L}{\partial EA_{it}^{3}} = 0 \Leftrightarrow R_{it}^{3,t} - \lambda \ = 0 \tag{17}$$

and the balance sheet constraint.
Thus one can writte:

$$\begin{aligned} & \frac{\partial EA_{it}^{1}}{\partial r_{it}^{2}}(R_{it}^{1} - R_{it}^{3,t}) + NA_{it}^{2} + \frac{\partial NA_{it}^{2}}{\partial r_{it}^{2}}(r_{it}^{2} - R_{it}^{3,t}) \\ & - \sum_{j} \frac{\partial ND_{it}^{j}}{\partial r_{it}^{2}}(s_{it}^{j} - R_{it}^{3,t}) \\ = \ & 0 \end{aligned} \tag{18}$$

9 Appendix 2

Loan interest rate (R^2_{it}) estimation (only for memory).

variable	coeff.	t-stat.	coeff.	t-stat.
constant	0.04709	19.47	0.04752	19.81
pibor3m	0.85275	13.05	0.84018	12.98
pibor3m*size	-0.04927	-0.98	-	-
pibor3m*rliq	-0.58737	-1.62	-	-
pibor3m*rcap	-0.46298	-0.30	-	-
size	-0.00214	-1.15	-0.00394	-13.99
rliq	0.00301	0.22	-0.01846	-9.08
rcap	-0.00655	-0.12	-0.02386	-3.00
R^2	0.22		0.22	

At the sample average, the impact of a one point change in the monetary policy indicator on the loan interest rate can be evaluated to 0.852 (which is close to the estimation obtained by Baumel and Sevestre (2000)).